

TMR read sensor configuration

The bottom electrode, #1, above would serve as a pinned layer for the formation of a TMR read sensor of either of the following configurations:

(A):

Ta80/SE Ta30/NiCr40/AFM/SyAP /Al 5.75/NOX/CoFe(10%)-NiFe(18%)/Ta

(B):

Ta80/SE Ta30/NiCr40/AFM/SyAP/Al 4.50-Hf 1.5/NOX/CoFe(10%)-NiFe(18%)/Ta

For read sensor operation the junction resistance should be as low as possible. The minimum barrier thickness, as estimated from a theoretical calculation, suggests that a layer of Al_2O_3 formed by the in-situ natural oxidation of two atomic layers of Al would already have a relatively wide band-gap, indicating good insulating properties. Two such layers, formed in the (111) atomic plane, have a thickness of approximately 5.75 angstroms. This is the layer indicated in (A) above. The layer in (B) substitutes a naturally oxidized Al-Hf layer for the Al layer.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig's. 1a-⁴_d are schematic cross-sectional views of the formation of an MTJ MRAM device using the method of the present invention.

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Fig's. 2a-d are schematic cross-sectional views of the formation of an TMR read head using the method of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment: MRAM device

The present invention, in a first preferred embodiment, is a method of forming an MTJ MRAM by the use of a novel NiCr seed layer formed on a sputter-etched Ta layer so that the subsequently formed tunneling junction layer is ultra-thin and smooth and has a high breakdown voltage. In a second preferred embodiment the present invention is a method of forming a TMR read head having a high GMR ratio, low junction resistance and high tunneling layer breakdown voltage, using the novel NiCr seed layer formed on a sputter-etched Ta layer.

Referring now to Fig. 1a, there is seen in a schematic cross section an initial stage of a preferred embodiment of the invention, the formation of a single MRAM element, which can be a part of an array of such elements. It is to be understood that in the embodiments to be disclosed in what follows, all layer depositions take place in an ultra-high vacuum system suitable for depositing thin layers by sputtering. In these embodiments the system was a commercially available Anelva 7100 system which